



# **Armed Forces College of Medicine AFCM**



## Thermal and pain sensations



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# INTENDED LEARNING OBJECTIVES (ILOs)



**By the end of this lecture the student will be able to:**

1. Describe thermo-receptive sensations.
2. List the general criteria of pain.
3. Explain primary and secondary hyperalgesia.
4. Compare superficial and deep pain



# Lecture Plan



1. Thermal sensation (15 min)
2. Pain & hyperalgesia (25 min)
3. Summary (5 min)
4. Lecture Quiz (5 min)

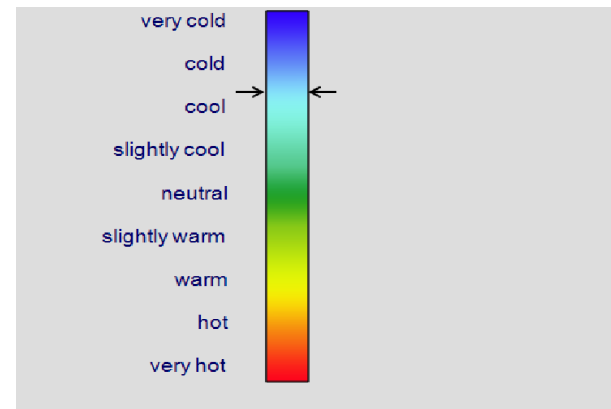
# Thermoceptive Sensation



**conscious  
perception  
of  
different  
grades of  
environme  
ntal  
temperatu  
re**



<https://atjenese.wordpress.com/2012/05/04/the-assessment-of-thermal-comfort-of-living-environment-in-tsunami-disaster-place/>

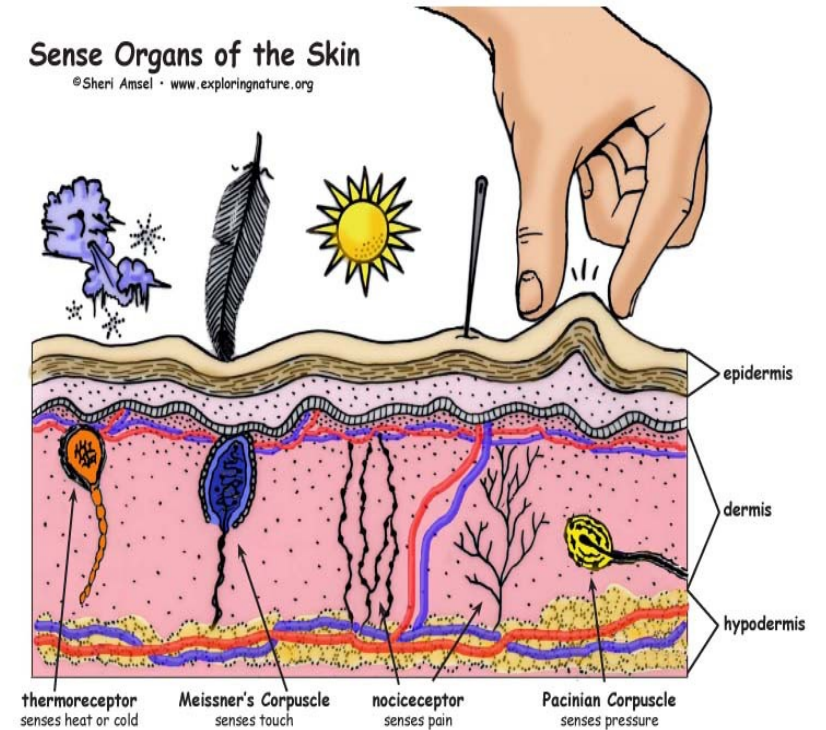


. Thermal sensation scale

<https://www.semanticscholar.org/paper/Thermal-sensation-and-comfort-models-for-and-Part-Zhang-Arens/6dab41f9689c769f7651620e315c7e71f3d63486/figure/2>

## Sense Organs of the Skin

© Sheri Amsel · www.exploringnature.org



<https://www.exploringnature.org/db/view/Sense-Organs-of-the-Skin>

# Thermoreceptors



## Types

warm

- Free n. endings (*C fibers*)

Cold

- Free n. endings (*C & A $\delta$  fibers*)

Cold pain

- Stimulated by *extremes* of temp.

Warm pain

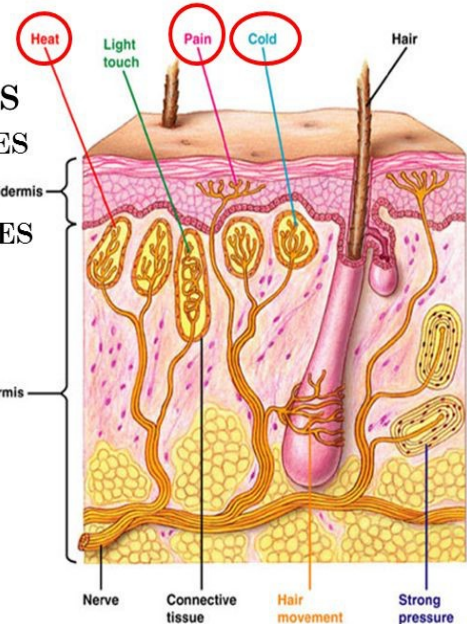
## OTHER SKIN RECEPTORS

### ◦ THERMORECEPTORS

- KRAUSE CORPUSCLES
  - Cold
- RUFFINI CORPUSCLES
  - Heat

### ◦ PAIN RECEPTORS

- Free nerve endings



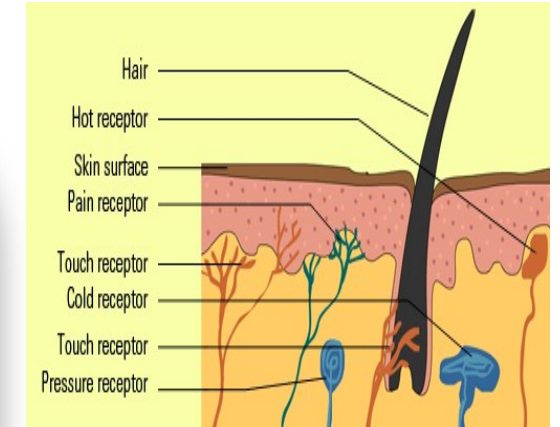
<https://slideplayer.com/slide/2385462/8/images/29/SKIN+SENSORY+RECEPTORS.jpg>

# Thermoreceptors

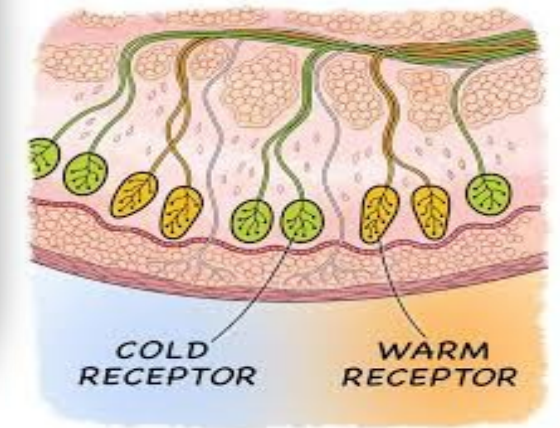


## Distribution

- ❑ Immediately **under the skin** ..... (respond to **temp. of SC tissue** around not ?? ).
- ❑ Distribution **differ** in different parts of the body .....**greatest** in **lips** **moderate** in **finger tips** **least** in **trunk**.
- ❑ Cold receptors >>>> warm receptors (**4-10** times).
- ❑ Widely **separated**. ..... (**wide area** of skin has to be exposed to differentiate different degrees of temp.).



<https://eschooltoday.com/science/the-five-senses/the-sense-of-touch.html>



<https://www.scientificamerican.com/article/cold-or-warm-can-we-really-tell/>

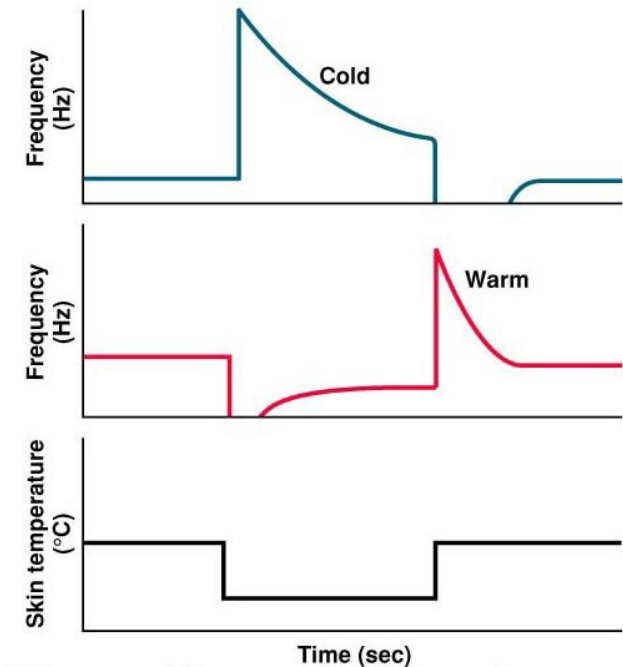


# Thermoreceptors



## Adaptation

- o **Moderately** adapting but warm receptors **faster** than cold R.
- o Respond markedly to **changing** temp. rather than steady temp.



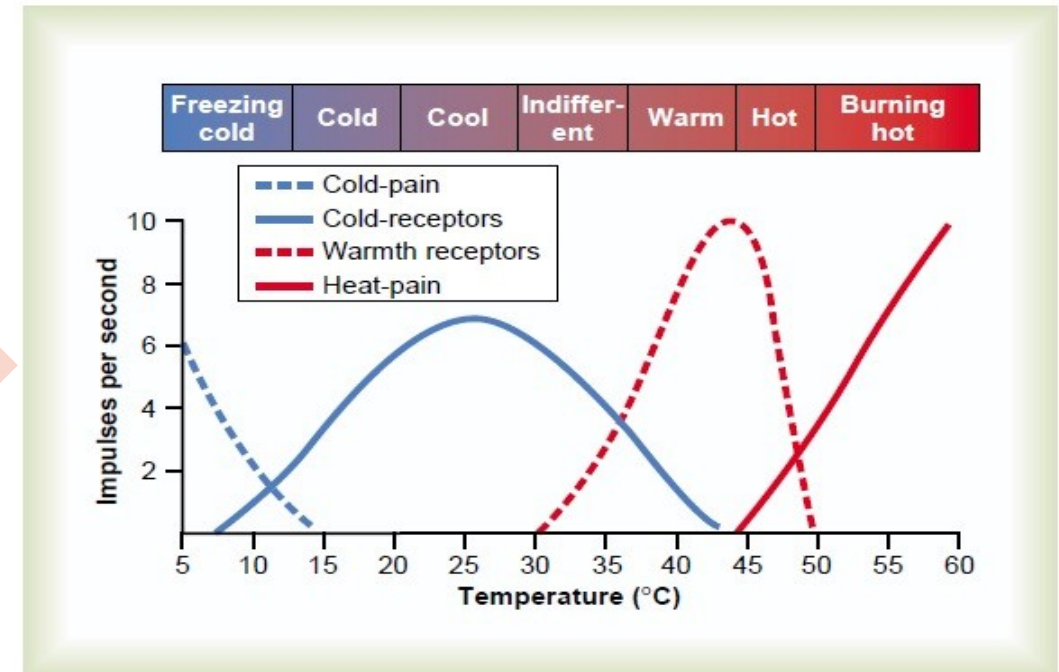
<https://www.d.umn.edu/~jfitzake/Lectures/UndergradPharmacy/SensoryPhysiology/Somatosensation/TempPerceptionExp.html>



# Detection of thermal sensation



- ✓ 5-15°C .....cold pain R.
- ✓ 10-40°C .....cold R.
- ✓ 30-50°C .....warm R.
- ✓  $\geq 45^\circ\text{C}$  .....warm pain R.
- ✓  $0^\circ\text{C}$  .....Anaesthesia .... NO receptor discharge
- ✓  $35^\circ\text{C}$  .....Neutral (**comfort zone**) ??



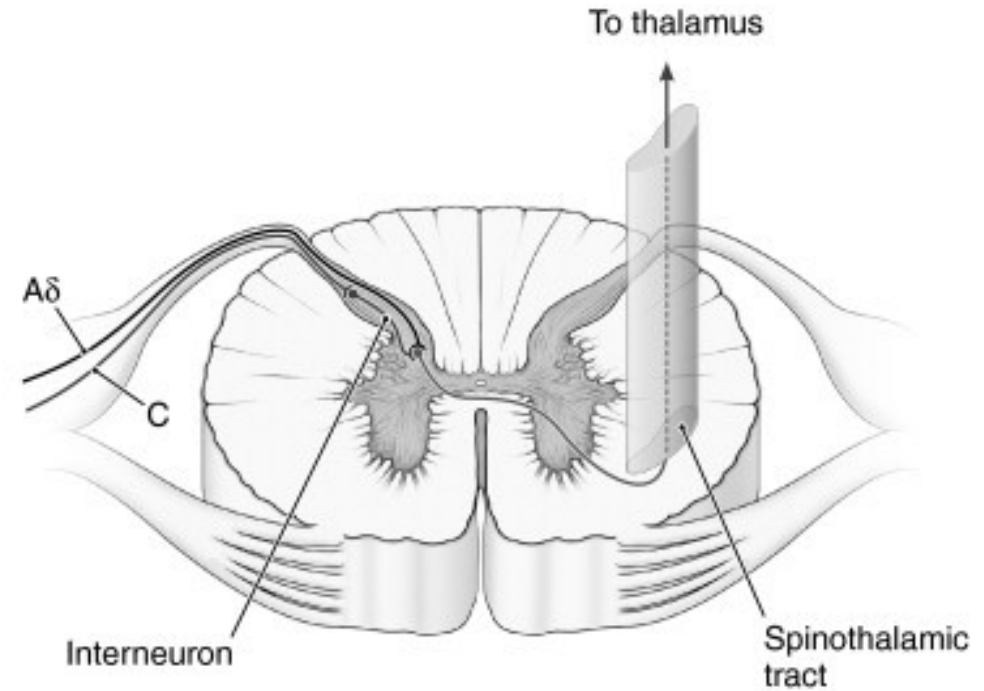
[https://www.brainkart.com/article/Thermal-Receptors-and-Their-Excitation\\_19664](https://www.brainkart.com/article/Thermal-Receptors-and-Their-Excitation_19664)

# Thermoceptive Sensation



*Pathway*

**lateral  
spinothalamic  
tract**



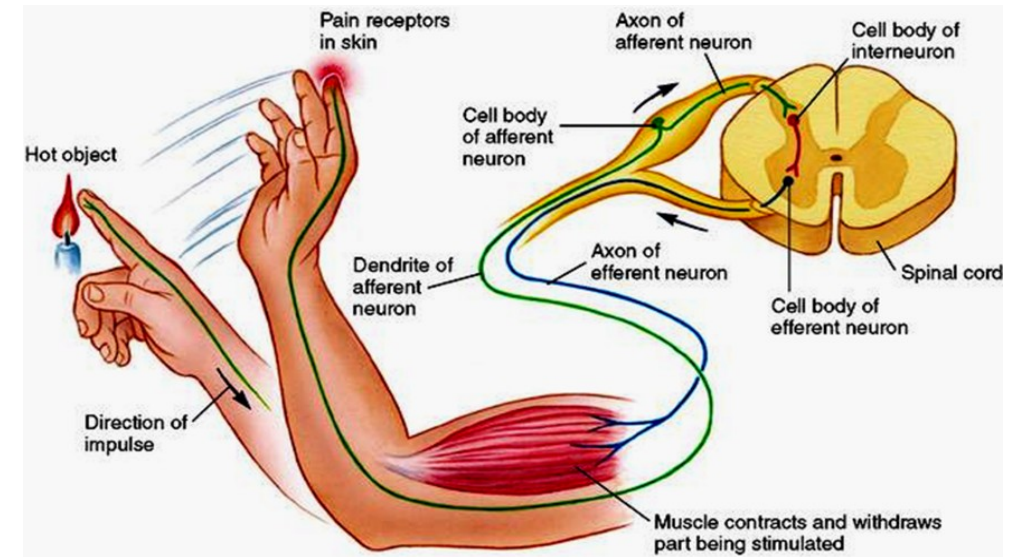
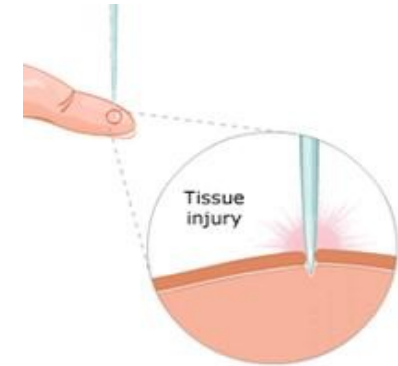
<https://www.sciencedirect.com/topics/medicine-and-dentistry/thermoreceptor>

# Pain



- ❑ **unpleasant** sensory and emotional experience.
- ❑ physical or potential **tissue damage**.
- ❑ For **protection** of the body (enable protective & behavioral response **preventing further tissue**

**d.** ✓ **Receptors:** *Free n. endings ( $A\delta$  & C fibers)*



<https://www.examrace.com/Study-Material/Medical-Science/Physiology/Reflex-Act>

# Pain receptors (**Nociceptors**)



## Types

**mechanical**

- Respond to **strong mechanical** forces (cutting, pricking)

**thermal**

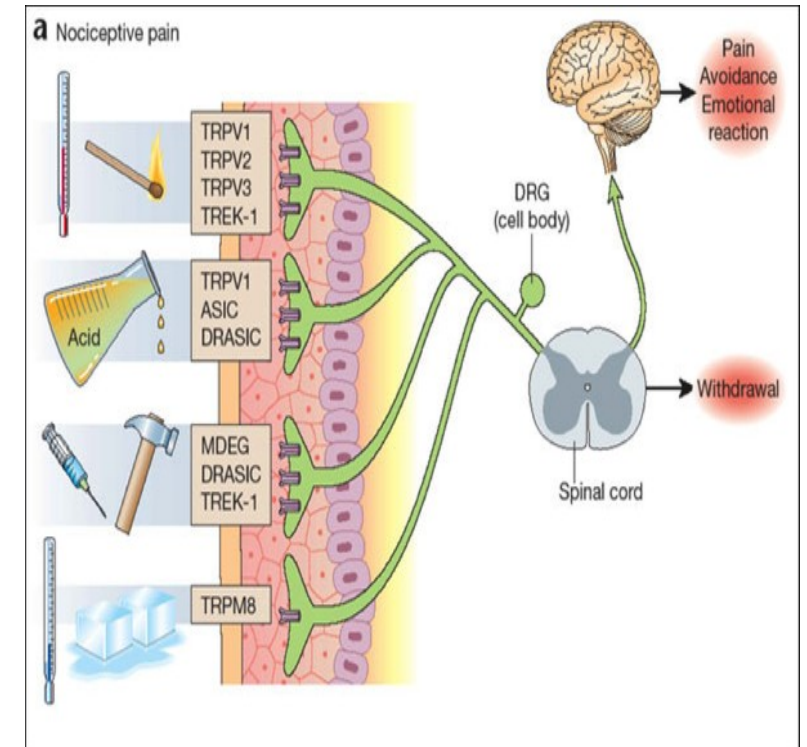
- Respond to **extremes of temp.** ( $>45^{\circ}\text{C}$  & below  $15^{\circ}\text{C}$ )

**chemical**

- Respond to injurious **chemicals** & those produced from **tissue damage**

**polymodal**

- Respond to **all stimuli**.



<https://www.animescience101.com/congenital-insensitivity-to-pain/pain-receptors>

# Pain receptors (**Nociceptors**)



## Distribution

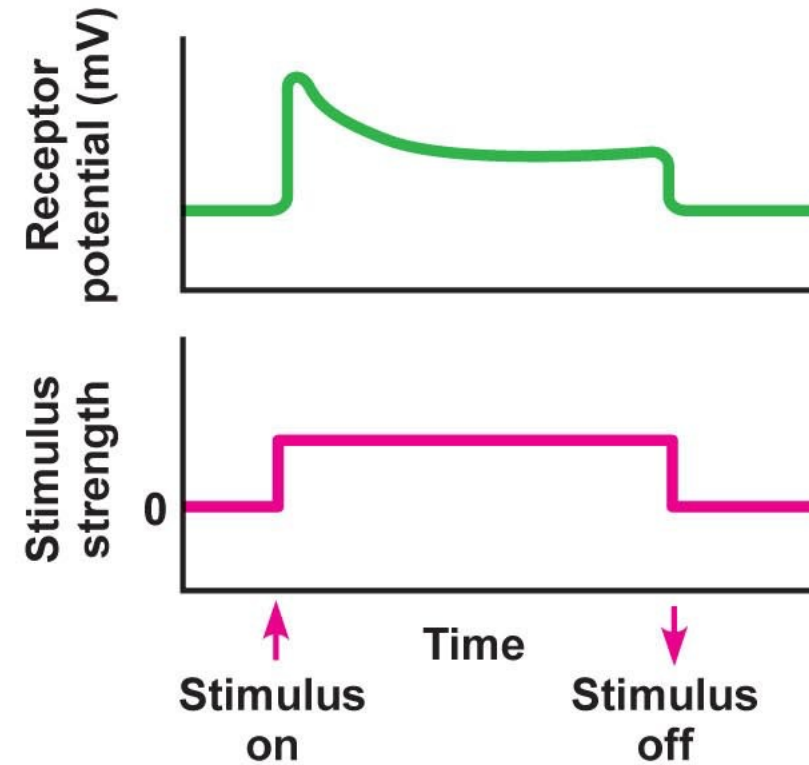
- ❑ **Most numerous** in the **skin**
- ❑ **Abundant (numerous)** in **peritoneum**, pleura, periosteum, joints, arterial walls, dura and tentorium of the cranial cavity.
- ❑ **Few** in **deep tissues** and all **viscera** ..... (For pain to occur, painful stimulus must be intense & widespread).
- ❑ **Absent** in **liver** parenchyma, **lung** alveoli, and **brain** tissue (**pain insensitive structures**).

# Nociceptors



## Adaptation

- o Slowly or Non-adaptive receptors

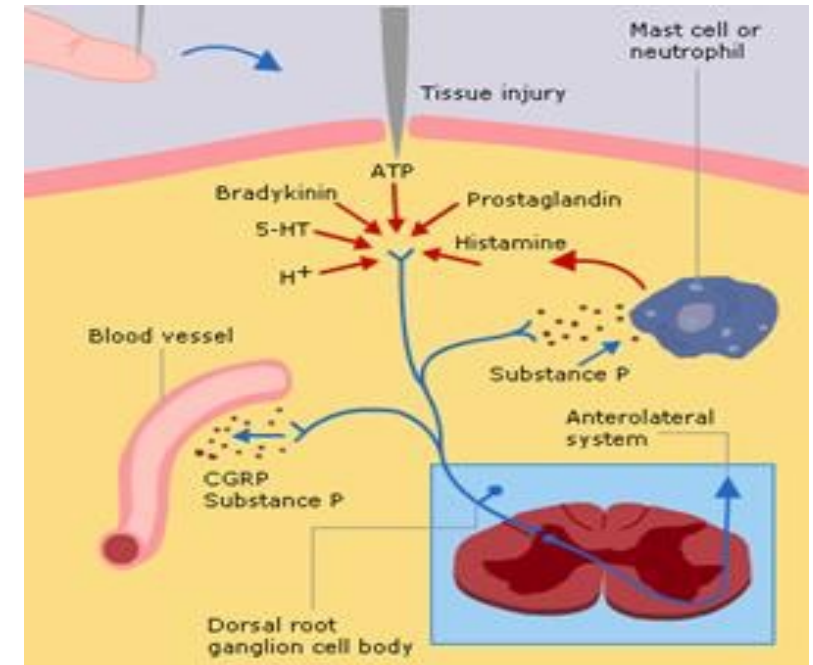


[http://droualb.faculty.mjc.edu/Course%20Materials/Physiology%20101/Chapter%20Notes/Fall%202011/chapter\\_10%20Fall%202011.htm](http://droualb.faculty.mjc.edu/Course%20Materials/Physiology%20101/Chapter%20Notes/Fall%202011/chapter_10%20Fall%202011.htm)

# Pain sensitizers



- pain and inflammation producing **chemical substances** released from the **damaged tissues** and the surrounding **blood vessels** **When??**
- □ **lowering** pain threshold of nociceptors (= **sensitization**) □ primary **hyperalgesia** that often accompanies pain.
- include histamine, serotonin, K<sup>+</sup>, substance P, ATP, bradykinin and prostaglandins (**Salicylates & NSAID ??**)



<https://www.rcemlearning.co.uk/reference/pain-management-in-adults/#1570786515026-faa7a79>



# Cutaneous hyperalgesia



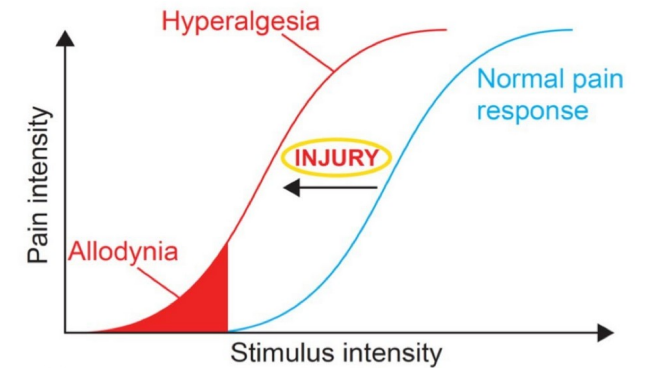
## Def.

**Exaggerated response to a noxious stimulus = increased pain sensitivity = an already painful stimulus now producing a **more severe** type of pain. DD.**

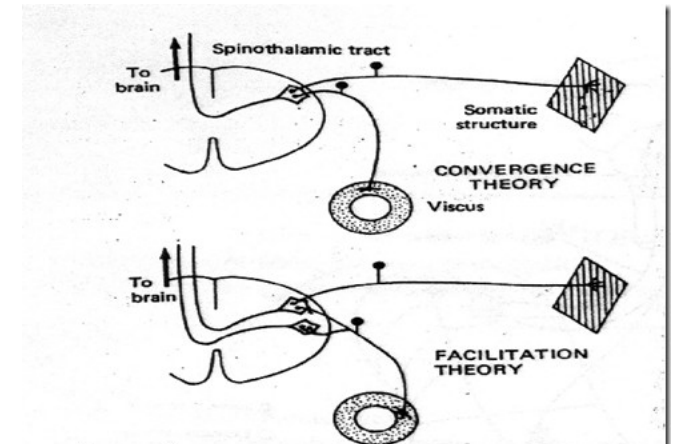
**Allodynia ??**

## Types

	Primary hyperalgesia	Secondary hyperalgesia
<b>Site</b>	injured area	healthy skin around the injured area
<b>Pain threshold</b>	Decreased	Normal may be even increased.
<b>Duration</b>	Longer	Shorter
<b>Mechanism</b>	Sensitization theory	Convergence- facilitation theory



<https://www.youtube.com/watch?v=zfqqi-sWZPQ>



<https://medatrio.com/pain-nociception>

# Types of pain (fast /slow )



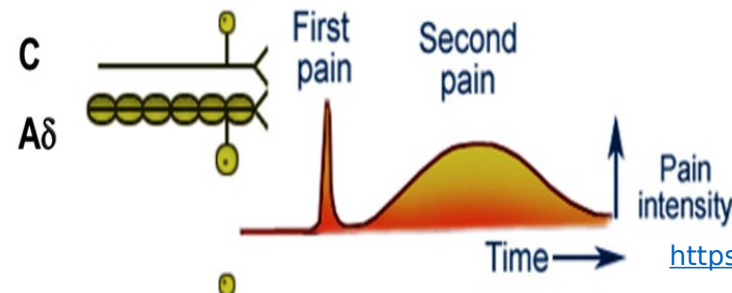
## Quality

Fast (Immediate) physiological pain	Slow (delayed) pathophysiological pain
<b>onset:</b> during application of the stimulus	Shortly after application if tissue damage occurs
<b>Duration:</b> short duration.	Longer duration
<b>Nature:</b> pricking	Burning
<b>Localization:</b> well-localized	Poorly-localized
<b>Afferent:</b> A-delta fibers	C-fibers
<b>Higher center:</b> CC	Thalamus
<b>Neurotransmitter:</b> glutamate	Substance-P
<b>Significance:</b> * determine site & severity. * Initiate withdrawal reflexes.	* Associated with arousal, autonomic & emotional reactions
<b>Abolished by</b> deep pressure and not abolished by morphine.	Abolished by local anaesthesia & morphine

<https://www.slideshare.net/medicmesirmansurah/pain-3353946>

	Acute (Fast)	Chronic (Slow)
<b>Source</b>	Skin only	Skin, deep tissues, and viscera
<b>Quality</b>	Pricking	Burning
<b>Onset</b>	Within 0.1 sec after stimulation	One or more seconds after stimulation
<b>Duration</b>	Short (one second)	Long (few minutes)
<b>Localization</b>	Well –localized	Diffuse
<b>Afferent</b>	A-delta	C
<b>Tract</b>	Neospinothalamic tract	Paleospinothalamic tract
<b>Centre</b>	Cerebral cortex	Thalamus
<b>Chemical trans.</b>	Glutamate	Substance P

<https://slideplayer.com/slide/4900931/>



<https://wellnessdoctorrx.com/neurophysiology-pain-part-i/>

# Types of pain (**cutaneous** / **deep** / **visceral**)



## origin

### Cutaneous pain

- From **skin** and **subcutaneous** tissues
- Usually **pricking** or **burning** pain

### Deep pain

- From **structures deep to the skin** e.g. skeletal ms, joints, and tendons
- Usually **dull aching** or **throbbing**

### Visceral pain

- From **internal viscera** e.g. stomach
- Usually **colicky** or **dull aching**

**Cutaneous pain is accurately localized:**

**Why??**

- ✓ ++ pain receptors in skin
- ✓ Reaches sensory cortex
- ✓ Touch & vision help localization

<https://slideplayer.com/slide/4900931/>

# *Causes of deep pain*



1-Trauma



2- Inflammation



<https://www.medicalnewstoday.com/articles/321835.php>

3- Ms. spasm



4-Ischemia



# Lecture Quiz



**Pain produced by tissue damage is due to release of which of the following?**

**a. Excess norepinephrine.**

**b. Bradykinins.**

**c. Heparin.**

**d. ATP.**



## Which of the following is correct regarding slow pain?

**a. Is carried along type A fibers.**

**b. Is perceived mainly in sensory area I.**

**c. Its pathway activates non specific thalamic nuclei.**

**d. Lasts for a short time.**

## SUGGESTED TEXTBOOKS



### **1. Guyton and Hall Textbook of Medical Physiology.**

<https://www.amazon.com/Guyton-Hall-Textbook-Medical-Physiology/dp/1455770051>

### **2. Ganong's Review of Medical Physiology, 25e.**

<https://www.amazon.com/Ganongs-Review-Medical-Physiology-Twenty-Fifth/dp/007182510X>





**Thank  
you!!**